SCIENCE

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KNOWLEDGE AND PRACTICE.*

THE honor of delivering the address upon this occasion is great; the responsibility of appearing as the successor of the distinguished men who have addressed you in previous years is also great, yet, as I thank you for your generous welcome, I feel, most of all, the pleasure of being the guest of Yale. To a Harvard man an honor bestowed by Yale has a special and very pleasant value.

Yale and Harvard have been working together for two centuries; their aims have always been similar; their developments have been parallel, and they have long sought one another for those friendly contests, intellectual and athletic, which yearly renew the close bonds between the two universities. I hope that their experience has been mutually helpful, for I am sure at least that Harvard has often learned from Yale, and they both have the same problems to solve if necessary.

Just at present there is a whole series of urgent problems in medical education before both institutions, and I shall, with your permission, try now to contribute to the discussion of some of those problems. You, who are upon the eve of graduation, know that you have received a far better preparation for the practice of medicine than was possible for any one to obtain a generation ago. You owe this advantage to the constant recognition of the possibility of improvement in medical education, and you should carry forth the feeling that it is now your duty to promote further progress in the organization and methods of medical schools. It is, therefore, eminently fitting

* Yale University Medical Commencement Address, June 29, 1899.

to the occasion to examine some of the possible ways of advancing medicine. Permit me, then, to lay before you certain suggestions which my experience as a teacher of medical science has brought to my mind. Others can deal far better than I with the strictly clinical problems. In the course of my address I shall have to emphasize certain limitations which are detrimental to medicine and which progress must step over. We must, however, not forget that criticism in itself is of slight value, unless it guides us to possibilities of progress. This interpretation of criticism should preside throughout our discussion.

The physician's work is not a trade in which he can perfect his skill once for all, but a profession based on learning, without interruption, new facts, new methods and even totally new ideas. The conversion of a student into a *medicinæ doctor* is too commonly looked upon as the end of the period of learning, but the student ought rather to look upon it as a certificate that he is at last qualified to learn, with reasonable efficiency, and, above all, with reasonable security as to his learning aright. Routine in medical practice is professional degradation.

There is one problem which we must all meet, the solution of which we cannot shirk, except by the supreme and final cowardice of suicide. So long as we live we are giving our solution to this problem, the problem of conduct, solving it equally by what we do and what we do not do, by our activities and our inhibitions. Some men give a mean solution, a mere summing-up of whims and accidents; others give the bad solution of selfishness, passion or vice. The great object of our universities is to aid men to reach a noble solution under the dominion of wisdom and uprightness. You will often hear the assertion that our colleges have one of their most important functions in the building-up of character. The college of which this is not true deserves no students. But with this assertion is sometimes coupled the implication that the professional and scientific schools do not exert as much influence as the college on character. Such an implication may be excused to ignorance, but that would be a sorry medical school of which it were true. A medical school must develop character as well as mind, or else fail to produce graduates who can solve their problems of professional as well as of personal conduct.

Conduct presents to us a fourfold aspect: a physical, a social, an æsthetic and an intellectual. The physical aspect is that which the physicans chiefly deal with, it being their work to regulate understandingly the doings of the body. To fit men for this work is the object of medical education. How to acheive this object I will ask you to discuss with me presently. The social aspect of conduct, the relation of what the individual does in its bearing upon others, has endless phases, but there is no profession in which the personal social relations are so much a part of the necessary professional equipment as in the profession of medicine. The practitioner must abound in conscientiousness, honor and tact, and it is a natural consequence that there exists a code of ethics wherever physicians have formed associations. The æsthetic side of conduct, the securing of beautiful things because they are beautiful, concerns the medical man less, although he pursues the art of healing, and healing is really an art, a very fine art, as well as a science. The intellectual aspect of his own conduct is to the physician sovereign over all the rest. Medicine is distinctively an intellectual occupation. Let this bare schedule suffice to emphasize the fact that the physician more than men in most occupations needs a varied endowment, a broad foundation of character and a liberal education. I think that physicians as a class are distinguished

by the breadth of their sympathies and by their manifold interests. This is the natural consequence of their having to deal constantly, for themselves and for others, with the problem of conduct in all its aspects.

In contrast with all these liberal qualities we find too commonly an attitude toward pure science and toward biology which seems to me much the reverse of liberal. I must go farther and say frankly that this prevailing attitude marks an important limitation of the medical profession, and that it points to defects in our system of medical education. Courageous acknowledgment of our needs is the first step towards satisfying them. I shall now endeavor to convince you that the criticism made is not only just, but that it discovers the way for vast educational progress, and I trust that in the end you will feel the point of view to be both friendly and helpful.

The mental attitude, the modification of which seems to me so desirable, reveals itself by distrust of pure science and by ignoring the relations of medicine to biology. Let us consider the case in its two phases.

First, then, as to science. To the academic proposition that science is the basis of medicine every one would assent, but, none the less, a great many practitioners still draw a sharp line between 'theoretical' and 'practical' doctors. Those who think this distinction are, of course, 'practical' men, and they are guilty of a triple error: first, that scientific is theoretical; second, that theoretical is impractical; third, that practical is superior to theoretical. This misconception still exerts influence, although it is certainly waning. Make it your part to hasten its extermination.

The feeling against medical science as impractical has been very strong in America, probably stronger than anywhere else in the world. Our colonial ancestors had to help themselves in every thing, and we have apparently inherited the belief that any way is the best way, and that expert capacity is a *luxe de trop*. We must remember, too, that medicine grew up as an art, not as a science, and that such progress as it made until this century was well along was chiefly by empirical experience.

It is only for about fifty years that research, properly so-called, has been an important factor, only about twenty-five years that it has been the leading factor in medical progress. It is, therefore, not to be wondered at that older practitioners, especially if without intercourse with university centers, are unconscious of the full measure of the change. The change is momentous, yet it has been so rapid that it falls largely within the period of the medical experience of many here present. Another curious factor in establishing and maintaining the notion that science is unpractical was the conventional idea of a scientific man, which prevailed even within thirty years, and which I can perfectly recall as a half-accepted standard when I decided to choose science for my career. This conventional scientist was a man past middle life, who wore an unfashionable hat, large spectacles, ill-fitting clothes, who was more or less absorbed in abstruse ideas and in studies of no practical use, really learned, very absent-minded and more rather than less in need of being looked after by somebody with common sense. It was almost necessary for a scientific man to cultivate absence of mind in order to sustain his reputation. It would certainly be an interesting study to trace the history of this phase of American science, since it was a phase, though a quaint one, of the eternal assertion that the best science is independent of immediate utilitarian consideration.

Resuming the direct course of our thought, we may say that on the one side the notion that 'scientific' is synonymous with 'unpractical' has its historical justification, but

on the other side it is now only a survival, an unjust opinion, a prejudice to be surrendered unconditionally. The prejudice against science has been very influential. Even fifteen years ago a young physician could not afford, no matter how much leisure he might have, to work in a scientific laboratory, because he would have been stigmatized as 'theoretical' and patients would have been turned away. I speak by chapter and verse, for I know many instances of young men beginning good research work, and then soon being compelled to give it up, by the force of professional opinion. We now know that this opinion was in large part a prejudice, the disappearance of which removes the final barrier across the entrance to the new era, which it has taken our entire century to open. The establishment of science in its rightful place has been going on steadily for a long period, but within five years it has rushed towards its culmination. We owe the complete medical recognition of the value of pure science to Bacteriology. Listen to the following dates. In 1879 Koch introduced the method of solid cultures; in 1882 he published his monograph announcing the discovery of the bacillus of tuberculosis. In 1884 came Löffler's paper on the bacillus of diphtheria. In 1891 appeared Councilman's account of the amœba of dysentery. At the International Medical Congress in 1893 Roux described the use of antitoxine in diphtheria, and about the same time McFadyean secured recognition for the value of mallein in the diagnosis of glanders. In 1896 came Vidal's reaction for identifying the germs of typhoid fever.

Here were results entirely beyond the ken of the practitioner, laboratory discoveries which he could only accept but not verify for himself, although in their application he could furnish dramatic proof of their value. No wonder that science now receives her meed.

It is safe to prophesy that hereafter medical science and medical practice will be both more sharply divided and more intimately correlated than heretofore. We already note that the experience of the clinician can rarely do more than effect improvements in methods, while the new principles come from the laboratories. The clinician may ask good questions, but he now depends so much upon the scientific worker for his answers that there is a sudden demand for laboratories in connection with every hospital. This demand marks the final unconditional surrender of the practitioner to pure science. The end is not yet. It is not enough that the value of scientific research is at last acknowledged, but the practitioner must also adopt the scientific method for himself.

What do I mean by the scientific method? There is much vague misconception concerning it, based upon the erroneous assumption that it is a peculiar method belonging to science. It is really only the right method of ascertaining the objective truth. It is in the classic words of von Baer, *Beobachtung und Reflexion*, observation and reasoning. The student at the microscope looking at nuclei and protoplasm and deriving therefrom a correct conception of the nature of a cell uses the scientific method, and he uses the scientific method again when he observes the symptoms of patients and reasons therefrom. There is nothing to distinguish the scientific method from the methods of every-day life except its precision. It is not a difference in kind or quality, but a quantitative difference, which marks the work of the true scientist and gives it validity. The definition of the scientific method seems simplicity itself, nevertheless it takes years upon years of the severest discipline to give even a partial mastery of the method, because to observe correctly and reason correctly are the most difficult accomplishments a man can

strive for, and he who acquires them to a high degree is a great man; such were Helmholtz, Darwin, Newton and a few others out of all time. The two grades of observation and reasoning must be distinguished, the lower repetitive grade and the higher original grade. Many a person of ability may be taught to see and understand that which has been seen and understood before. Such persons in medicine can make correct diagnoses of known diseases, but in the presence of the new unknown they fail. Such persons in science may do good work as followers, not leaders—privates, not generals. To the few are accorded the privileges of the higher grade, right sight and right thought as they invade the unknown. The training in exact science does more than any other discipline to elevate those who have sufficiently great gifts into this highest intellectual grade. We say, therefore, unhesitatingly that severe scientific education is the principal addition we ought to make to our medical curriculum. So I come back to my opening assertion: We must teach how to learn, and how to learn from the unknown.

If we admit the principle that science should have a more influential place than at present we must decide in what way that place can be provided. It is, I think, undesirable to lengthen the medical course beyond the four years now required; it is undesirable to omit any of the subjects now offered, and it is equally undesirable to enlarge greatly the fundamental scientific courses in anatomy, physiology, pathology, etc. We seem surrounded by impassable walls, but there are two considerations which may guide us. On the one hand is the enormous growth of medical knowledge, which is beyond the power of any single student to master, so that some choice must be made for him or by him. On the other hand the science we are now seeking a place for is not that which is basal, but that which is to perfect and end the whole training; it is to be the top, not the foundation. Clearly, then, the way out is to introduce the elective system on a large scale into the fourth and perhaps third year. Make a series of these electives for advanced work in scientific subjects, such as anatomy, embryology, physiology, pathology, pharmacology, bacteriology. As you know, this solution has been tried, and with most encouraging results. May we not look forward to its becoming the universal method throughout America?

As regards the elective system I follow Dr. Henry P. Bowditch in believing that it should be greatly extended, and that the required studies in medicine should be reduced to the minimum, and numerous electives provided for every year of study. These proposed electives may be in subjects already taught and also may provide courses not usually offered, such, for example, as examination of the blood, pathological chemistry and psychology in its medical aspects. The elective system is the educational answer to the tendency toward specialization in practice, and I believe that we have no choice as to its adoption.

We pass on to the consideration of the second phase of the case which we are debating. It will probably need a much longer and more sustained effort to bring about a correct recognition of the relations of medicine to biology than is needed to win recognition for science at large.

Medicine is one department of applied biology, just as dyeing is one department of applied chemistry, or electric lighting a department of applied physics. Now if a man wishes to become an expert dyer or electrician he studies chemistry as a whole and physics as a whole, but the would-be physician begins at once with human anatomy and human physiology, and probably to the end of his days never discovers that he has no conception whatever of biological

science. Carl Semper used to say, *die Mediziner sind lauter verdorbene Zoologen*—the medical men are all spoilt zoologists—and the saying still remains only too nearly true.

The first question is: What place shall be given to biology in medical education? In order to answer this question we must remember that biology should here serve a twofold purpose, that of making the beginning so as to lay the proper foundation for further study and that of inculcating the value of the comparative method.

The fundamental principles of biology ought to be taught to every student of medicine before he is allowed to study medical anatomy or physiology. This great reform will surely come about, and has, in fact, been already effected by one important university, which has made biology a requirement for admission to its medical school. Or perhaps the necessary time can be secured, after the student has entered the medical school, by lessening the number of hours now required for anatomy. That far more time is usually devoted to anatomy than is advantageous to the student I am thoroughly convinced. Formerly, when gross anatomy gave the student almost his only training in exact scientific observation, the subject had a pedagogic value, which it has since lost in very large measure, because histology, experimental physiology, bacteriology and pathology offer far better discipline of the observational power than anatomy alone can supply.

It must be further remembered that a large part of anatomy is to the student sheer memorizing and without intellectual value. Finally, we all know that a large proportion of the facts of descriptive anatomy are speedily forgotten after the examinations are past, and that the practitioner finds no occasion to recall them. A study which occupies so many hours as to exclude other valuable forms of mental training and imparts much information not of practical value may well be abbreviated. On the other hand, a thorough course in descriptive anatomy, exclusive of histology and surgical anatomy, must always be indispensable. The only question is concerning the proportionate division of time with the other studies, which within recent years have become equally indispensable.

My second point is the inculcation of the value of the comparative method, to which the development of biological science is mainly due. Life presents itself in an immense variety of species, and the vital phenomena assume a characteristic manifestation in each species. It is by comparing the structure and functions that we are able to distinguish the fundamental and essential part of the phenomena from that which is secondary, and thus we gradually reach those generalizations which alone constitute true science. A detail is a grain of earth, useless for building until it is compacted with many other grains into a useful shape, which, hardened, like a brick, in the furnace of thought, can be added to the temple of knowledge. Now, since medical interest centers in man, medical investigators have cared little for comparative research, and have often failed to grasp the problems with which they dealt. Many an able physician, when he studies, say the physiology or pathology of a dog, a guniea pig or a frog, honestly thinks that he is studying comparative physiology or comparative pathology, although he is really doing nothing of the kind. He is studying, perhaps, gastric digestion or the hypertrophic degeneration of the liver; he seeks to understand the process in the one organ or the other, and the stomach is to him the stomach, the liver the liver. He may note the differences between one animal and another if they are marked, but he does not attempt to determine the process in the carnivora, the rodents and the amphibia, see what is common to them all, and what is special modi-

fication for each of these groups. One has only to read any accepted text-book of physiology or pathology to see that it is absolutely true that the narrow or anthropomorphic view is the typical medical view. The medical man may learn from the zoologist and botanist, who have depended chiefly upon the comparative method for their most important results. Science cannot be hampered by any conventional restriction; it must be free to turn in every direction in which a discovery is possible. Now, medicine places a conventional restriction around the medical sciences, for by custom and precedent it orders that, even though the actual investigation be upon some animal, it shall be regarded solely as elucidating human structure and human function—in other words, the interpretation must be anthropomorphic. This convention has led to some strange absurdities, of which I shall mention only one; the microscopic structure of the kidney has been investigated chiefly in animals, notably the dog and rabbit; all the text-books of anatomy and histology known to me, with a solitary exception, describe the structure of the human kidney in accordance with the observations on these animals; but, as the human kidney really differs in many important respects from that of the dog and the rabbit, the structure of the *human kidney* still remains generally unknown. This error has been perpetuated through fifty years. Since zoologists are habituated to the comparative method, would it not be wholly impossible for a blunder of this kind to be kept up in their work?

I am so thoroughly convinced of the value of the comparative method, of the absolute necessity of its adoption in medical research, that I look forward to its acceptance as the greatest advance in medicine which our time will know. Methods of obtaining knowledge are the means of progress. Remember how much anatomy owes to the method of human dissection; how much pathology owes to the method of staining microscopical preparations; how much surgery owes to the method of antisepsis; how much bacteriology owes to the method of artificial cultures. These are, however, merely technical methods, but that which I am now advocating is a mental method, a way of successful thinking, a process of right reasoning, far more comprehensive than any technical method; and, if we accept it, we can explore vast regions of knowledge, the very possibilities of which we barely recognize now. Let it encourage us that the comparative anatomist and comparative embryologist are already well advanced along the path which the physiologist and pathologist must now learn to follow.

Medicine is destined to become comparative, because it must advance. The wise action for us is to facilitate that advance, and thus the question becomes: What shall we do practically to establish and promote comparative medicine? If we agree that our aim is to secure the very best kind of research in medical science the practical answer is clear: We must provide post-graduate instruction, with courses thoroughly systematized and correlated, covering at least two years, to qualify men to become professional investigators in the comparative sciences of morphology, physiology, pathology, bacteriology, preventive medicine, etc. It is remarkable that these sciences have never reached a university standing. It ought now to be secured. If a young man wishes to make a scientific career, if his interest is chemistry, physics, botany or zoology, he is received at one of our universities started upon a well-planned course properly systematized, he gives for two or three years most of his strength to his main subject, but he follows probably two cognate subjects as minor studies, and at the end of his time, if successful in his

work, he receives a degree, which attests his proficiency in his special science. Should the same young man elect to study one of the medical sciences, physiology, pathology or bacteriology, no university will give him corresponding recognition. The utmost he can find is opportunity for advanced work in his special subject, but with no university guidance, no plan of correlated studies, and he can look forward to no degree nor even to a certificate from the university. Must we not admit that here is a great omission in our university organization? Is it not a pressing duty to repair this omission? Surely to put these questions is to assent to them.

We are thus brought to the conclusion that, though the primary function of our medical schools is to educate practitioners of medicine, yet they ought to assume now the further and higher function of training medical investigators. To succeed in this the medical laboratories must be expanded, their resources enlarged and the staff increased, so that the officers will have time and means for both researches of their own and for guiding the researches of advanced students. Yale has been teaching a needed lesson, for her laboratory of physiological chemistry has shown what splendid results ensue when one of the so-called medical sciences is set free and allowed to develop as the peer of other sciences. Untrammel them, strike off their bonds, and comparative morphology, comparative physiology and comparative pathology will develop and add to the good work and glory of your alma mater as physiological chemistry has already done.

Laboratories are of very recent origin; seventy-five years ago there were none. There are but few laboratories which have stood for as much as twenty-five years. Our experience with them has not been long, but we have learned two things concerning them: that they are absolutely indispensable and that they are very costly, so costly that a university has become an enterprise of great financial magnitude. Formerly a college with an endowment of a million dollars was wealthy; at present a university with three thousand students and twenty millions dollars has to practice rigid economy to keep running properly. We who are at work for universities are painfully conscious of needs, and it seems to me a common duty for us all to make known to the public, upon whose generosity American higher education depends, the true scale of those needs.

The requirements of comparative medicine call for more changes than we have yet mentioned. The very word comparative implies that animals shall be included in the range of study. It means that not only shall provision be made for investigating the structure of animals and for physiological experiments, but also for the observation and treatment of sick animals, or, in other words, there ought to be a veterinary hospital in intimate association with the school of human medicine. Such a hospital would increase the range of experience and contribute a broadening impulse to all medical work. It is, I believe, quite a new project to consolidate the interests of veterinary and human medicine, but it is, by the initiative of President Eliot, under actual consideration at Harvard, and will, if carried out, be an epoch-making advance. It will be a public and effectual assertion of the solidarity of all medical science and of all forms of medical practice. It will be a boon to pathological and clinical research, for it will offer opportunities for the study not only of diseases specially characteristic of animals (such as the distemper of dogs), but also of those diseases common to man and animals. We are thus brought round to still another aspect of the beneficence of medical consolidation, the future development of preventive medicine.

Preventive medicine is a term of recent currency. We have come to think more about it in consequence of the growth of our knowledge of disease-germs, which has led to the hope that we can control germs, so as to prevent or at least greatly diminish the danger of infections. Moreover, serum-therapy, the anti-toxin treatment and the discovery of the influence of the thyroid and suprarenal extracts have made us familiar with the conception that profound influences may be exerted by quantitatively slight changes in the chemical conditions within the body. Here are two illustrations of ways in which disease may be impeded. It is a field which might be considered a part of that of hygiene, but it is logically distinct. To stop disease is not the same as preserving health. Now, we are all agreed that prevention is a rapidly increasing part of medical practice, and, since many diseases, like tuberculosis, typhoid fever or the bubonic plague, are spread by animals, it follows that we must look upon the study of diseases of animals as an integral and indispensable portion of preventive medicine. A hospital is as necessary for the observation and treatment of sick animals as of sick men.

Most of us, I am sure, anticipate in the near future a magnificent development of preventive medicine. One of the best means to promote the fulfilment of these anticipations is to bring the veterinary hospital into close and intimate union with the medical school.

The veterinary profession, like the medical, is raising its standards rapidly, and we can only wish success to these efforts, for not only does the case of sick animals require the highest skill, but also the advance of veterinary science calls for the best scientific ability. If veterinary schools are brought, by means of their hospitals, into close touch with medical schools it will hasten the elevation of the veterinary profession, and will bring nearer the time we all shall say that the veterinary school is as worthy a place in the university organization as is the medical school. When that time comes, as the foundations of medicine will be broad and wisely laid, so will the superstructure be stable.

As for the fear, which I heard expressed at a recent medical meeting, that doctors are destroying their own means of livelihood, because preventive medicine is limiting the supply of diseases to be cured, I may say that fear has not limited the eagerness of physicians to increase prevention. On the other hand, there is the consoling hypothesis that there are likely to remain many diseases, especially those which are difficult to identify and to treat and also those of sporadic occurrence, which will keep practitioners busy in the future. As the time is passing away when a large part of active practice consisted in cases of typhoid, diphtheria and other preventable diseases, rarer forms of illness will be more thoroughly studied, and, as they will require a higher skill, the future physician will seek a better training than we can offer to-day. Thus one of the indirect results of the advance of preventive medicine is to raise the standard of medical education.

I have said enough to indicate the far-reaching consequences of the conviction, which I hold and hope you hold, that the comparative method of biology is to direct the development of medical practice. The adoption of the comparative method will revolutionize both medical teaching and the organization of our medical schools.

We must now turn our attention to certain other questions of medical education. During the past year there has been going on a very widespread discussion in this country over the curriculum for medical students, and the prospect of consequent improvement is encouraging. I cannot venture upon attempting more than the

presentation of certain definite ideas which have formed themselves in my own mind as the result of the late discussion, and must leave to others a more comprehensive treatment.

Foremost in importance is the idea that the number of lectures is too great, probably, in every course given, and that the laboratory work and the personal clinical work occupy too small a proportion of the student's time. The practical work is the instructive work; it is the source of real knowledge. The actual direct contact with the objects and with the phenomena *is* knowledge. The very best that can be said of a lecture or a book is that it describes well the knowledge which someone possesses. There is no knowledge in books, and that motto ought to be inscribed over the library door. A book or lecture can serve only to assist a man to acquire knowledge with lessened loss of time. Knowledge lives in the laboratory; when it is dead we bury it, decently, in a book. Now real knowledge is what the medical practitioner needs, the personal mental image of things seen, felt and heard; he needs to establish a short circuit between sensations and the true psychic concept, but if you train him to interpolate books you are likely to make the circuit so long that there will be no true concept at the end of such a resistance path. Our greatest discovery in scientific teaching is the discovery of the value of the laboratory and its immeasurable superiority to the book in itself. A lecture is a spoken book, and must, therefore, also yield to the superior claims of first-hand knowledge.

It is the corollary of the value of laboratory instruction that the examinations should be practical, or, in other words, that the conventional written examination should be given up. All the clinical work is, of course, to be classed as laboratory instruction, and the time ought not to be far distant when students will be required to make diagnoses from patients directly as the test of their proficiency. No one who has examined students in both ways is likely to question the superiority of the practical examination over the written. It is a real test of real knowledge, and is fair to the student for that very reason, and it avoids the two defects of the old-fashioned examination paper: first, the defect of testing memory rather than mental power; second, the defect of offering rewards for cramming. A practical examination has the great advantage of emphasizing to every student the necessity of personal familiarity with the objective basis of his studies.

A second important idea is that the requirements for a medical degree shall no longer be uniform for all candidates. That this idea will be adopted is necessarily the belief of every one who advocates the elective system.

A new arrangement of studies has been adopted by the Faculty of the Harvard Medical to go into effect next year. It is the result of prolonged careful debate. It is based upon three leading principles, concentration, correlation and sequence of subjects. The system consists in a division of studies by half years and by half days within the half year. The elementary anatomy will be confined to the first term of the first year, but will occupy half of every day; the other half of every day will be occupied by histology, embryology and a special course on the brain. In the second term a similar system will be followed, half a day for physiology and half a day for physiological chemistry. In the first term of the second year this simple dual plan is pursued with pathology and bacteriology; beyond this the arrangement is more elaborate, and for the third and fourth years is not yet fixed.

The new plan is, of course, an experiment, but is fully expected to prove a successful one, because it will make the work

of the student easier by concentrating his thoughts upon one subject instead of dissipating his attention among many subjects. If a man wishes to accomplish intellectual labor he seeks instinctively to apply himself wholly to that one task until it is completed. The capacity for sustained effort is the power by which the man surpasses the child. The child needs constant change and variety, and the system, which we have had in our school, of running from one lecture to another and from one laboratory to another, appears to many of us more suitable for school children than for young men studying medicine, and we expect, therefore, the new plan of studies to be justified by its results.

Here we must pause, although we have merely touched upon general principles and looked at a few details as illustrations. It seems to me that the whole problem of medical education is just now one of the most interesting and important ever presented in the history of American universities. If I have stimulated your interest in it I am rewarded.

Before I close I will venture to address to those of you who are to-morrow to receive your medical degrees a few words upon the deeper signification of your profession. This is not the time to enter into a discussion of the assumed antagonism between practical science and Christian faith. Each year brings the two into closer and more helpful relationship and increases their mutual understanding. The dignified agnosticism of Huxley and the lofty spiritualism of Brooks meet in the common conviction that the growth and development of man to a higher and better physical and spiritual life is alone what makes existence worthy.

We are living in an epoch of great scientific discovery and of consequent material progress, which among its many results includes numerous new facilities for intercourse between nations. In contemplating these facilities one recalls how great a part the free intercourse under the great Roman Empire played in the first spread of Christianity, so that one involuntarily asks: Is not science now aiding the same cause in a similar way? Science does more. By its steadfast pursuit of truth; by its broad-minded ability to acknowledge the truth whatever found; by its freedom from narrow dogmatism on the one hand, and from ignorant materialism on the other, science can do a noble work in the great battle between good and evil in the world.

The antagonism of science and religion is unreal. Our intellectual Quixotes take it for one of their windmills, but I very much doubt if it be more than the phantom of a windmill. When you, young men, begin your life's campaign, fight real foes, be blind to threatening phantoms and deaf to their noisy shibboleths. Attack real difficulties. Remember always that as physicians you will have to help others, and that it will be peculiarly your obligation to uphold the standard of faithful service and to defend what I may call the creed of science: that the advancement of knowledge is a duty because it serves mankind. Faithful scientific research is Christian service.

CHARLES SEDGWICK MINOT.

LORD KELVIN'S ADDRESS ON THE AGE OF THE EARTH AS AN ABODE FITTED FOR LIFE.

II.

A THIRD line of argument relative to the habitable era of the earth is drawn from the theoretical age of the sun. After stating the probability that, if sunlight was ready, the earth was ready both for vegetable and animal life within a century, or at least a few centuries, after the consolidation of the earth's surface, Lord Kelvin inquires whether the sun was ready, and re-